CALIFORNIA DIVISION OF MINES AND GEOLOGY

FAULT EVALUATION REPORT FER-113

February 24, 1981

1. Name of fault

San Andreas fault, Zayante fault

2. Location of fault

Watsonville East and Chittenden 7.5-minute quadrangles, San Benito and Santa Cruz Counties (figure 1).

3. Reason for evaluation

Part of 10-year fault evaluation program (Hart, 1980).

4. List of References

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Ross, D.C. and Brabb, E.E., 1973, Petrography and structural relations of granitic basement rocks in the Monterey Bay area, California: U.S. Geological Survey Journal of Research, v. 1, no. 3, p. 273-282.

Sarna-Wojcicki, A.M., Pampeyan, E.H., and Hall, N.T., 1975, Maps showing recently active breaks along the San Andreas fault between the central Santa Cruz Mountains and the northern Gabilian Range, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-650, scale 1:24,000.

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U.S. Department of Agriculture, 1963, Aerial photos, CIV-6DD 170 to 173 and 225 to 228, black and white, vertical, scale approximately 1:21,000.

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5. Review of available data, and air photo interpretation.

San Andreas Fault

The San Andreas fault zone depicted on the 1976 Special Studies Zones (SSZ) Map of the Watsonville East 7.5-minute quadrangle is based on mapping by Farrington (1974) and Hall and others (1974)(figure 2a). The San Andreas fault zone depicted on the 1974 SSZ Map of the Chittenden 7.5-minute quadrangle is based on mapping by Allen(1946), Clark (1970), and Farrington (1974)(figure 2b).

Land surfaces along the San Andreas fault zone in this Fault Evaluation Report (FER) area have not been significantly altered by man. The fault zone generally is located along the southwest-facing slopes of the Santa Cruz Mountains in the Watsonville East quadrangle, and along the course of Pajaro River for about 1 1/2 kilometers, and within a linear valley parallel to Anzar Road in the Chittenden quadrangle.

Historic surface fault rupture occurred along this segment of the San Andreas fault zone during the 1906 M8 earthquake (Lawson, 1908). The railroad bridge across Pajaro River was offset 3.5 feet in a right-lateral sense (Lawson, 1908)(figure 2b). A fence "halfway between the (railroad) bridge and San Juan (Bautista)" was offset 4 feet right-laterally (figure 4b). Unfortunately, this fence was not specifically located in Lawson's description, and an individual fault trace cannot be associated with the reported surface rupture.

Landsliding along the segment of the San Andreas fault zone in the Watsonville East quadrangle is very predominant. Slope failures seem to be concentrated along the fault zone and occasionally obliterate or mimic fault-related geomorphic features (figure 4a). Lawson (1908, p. 38 and 110) reports that landsliding along this zone from the Pajaro River northwest was very widespread.

The northernmost extent of fault creep along the San Andreas fault in central California is located in the Watsonville East quadrangle (Burford and Harsh, 1980). A U.S.G.S. alinement array (about 85 meters in length) is located near the Chamberlain bench mark (figure 4a). The average slip rate, measured from 1967 to 1972, was 0.8 mm/year. This slip rate, when compared with 8 mm/year measured about 11 3/4 km southeast near San Juan Bautista and 12.3 mm/year measured about 29 km southeast at the Almaden winery, indicates that fault creep is diminishing within the FER study area (Burford and Harsh, 1980).

The San Andreas fault zone mapped by Hall and others (1974) is a wide zone of faulting in the Watsonville East quadrangle (figure 2a). A later map by Sarna-Wojcicki and others (1975) depicts the San Andreas fault zone essentially the same as Hall and others (1974), although the scale and base map used by Sarna-Wojcicki and others is much improved. Many of the branch faults of the San Andreas fault zone shown as inferred on the 1976 SSZ Map of the Watsonville East quadrangle are mapped as concealed by Sarna-Wojcicki and others (figure 2a). Geomorphic evidence for Holocene faulting along these faults cannot be found, based on air photo interpretation by Hart (1979), Smith (1979), and this writer (figures 2a, 3, 4a). Many features, such as benches and closed depressions, are caused by landsliding in this area rather than faulting (figures 2a, 4a). Farrington (1974) does not map these traces away from the main trace San Andreas fault (figure 2a). Dibblee and Brabb (1978) map the San Andreas fault along a very narrow zone and do not show the branch faults of Hall and others (1974) and Sarna-Wojcicki and others (1975). (2) (3)

Although numerous landslides along the fault zone complicate the geomorphic evidence for Holocene faulting, locally well-defined fault traces characterize the San Andreas fault zone in the Watsonville East quadrangle, based on air photo interpretation by Hart (1979), Smith (1979), and this writer (figures 3, 4a). Systematic right-lateral offset of drainages, numerous closed depressions associated with scarps and troughs, and ponded alluvium indicate Holocene faulting (figure 4a). Specific locations where surface fault rupture occurred during the 1906 earthquake are not well-documented (except for the railroad bridge across Pajaro River), but Lawson (1908) indicates that surface rupture occurred within the general location of the main trace San Andreas fault in the Watsonville East quadrangle. Surface fault rupture was probably distributive in the Mt. Pajaro-Pajaro Gap area (Lawson, 1908, p. 38).

The San Andreas fault shown on the 1974 SSZ Map of the Chittenden quadrangle is based on mapping by Allen (1946), Clark (1970), and Farrington (1974) (figure 2b). Traces of the San Andreas fault by Clark (1970) are based on Allen (1946) and were compiled at a scale of 1:125,000. An unidentified trace of the San Andreas fault shown on the 1974 SSZ Map of the Chittenden quadrangle is probably based on mapping by Bishop (1969) (figure 2b), but is not cited on the SSZ map. Mapping (4)
completed since the 1974 SSZ Map was issued includes Sarna-Wojcicki and others (1975) and Dibblee and Brabb (1978).

The railroad bridge across Pajaro River was offset 3.5 feet right-laterally during the 1906 earthquake (Lawson, 1908)(figure 2b). A fence was offset 4 feet right-laterally during the 1906 earthquake and is located "halfway between the (railroad) bridge and San Juan (Bautista) (Lawson, 1908, p. 38), somewhere in the general area of the linear valley parallel to Anzar Road (figure 4b).

Less well-defined fault traces characterize the San Andreas fault zone in the Chittenden quadrangle, based on air photo interpretation by this writer (figure 4b). The fault is located along the course of the Pajaro River for about 1 1/2 km into the Chittenden quadrangle. The fault leaves the Pajaro River channel near Chittenden and generally follows the linear valley southeast of Anzar Lake (figure 2b). A subparallel fault trace northeast of Anzar Lake is defined by closed depressions, troughs, and southwest-facing fault scarps.

The subparallel fault trace is in the general location where Allen (1946) and Farrington (1974) show a fault (figures 2b, 4b).

A short fault trace associated with a sag pond is thought by Farrington (1974) to have ruptured during the 1906 earthquake (figures 2b, 4b), based on the description of a sag pond and a photo in the Lawson report (Plate 17B; figure 6, this report). However, no maps of this area accompanied the report, which is vague with respect to the accurate location of the feature (Lawson, 1908, p. 38). Also, Plate 17B (figure 6) illustrates a sag pond that may not be the pond Farrington refers to . Although the view of the photo is not given, it is apparently to the northwest, based on topographic features and vegetation patterns in the background that are similar to features near Pajaro Gap. If the view is to the northwest from the depression Farrington maps then a 60-foot high hill should block the view of Pajaro Gap and the hills to the northwest. Additionally, this sag pond is not associated with any fault-related geomorphic features northwest or southeast of its location. It is more likely that the sag pond referred to by Lawson is located along the moderately well-defined fault trace to the southwest (figure 4b).

A broad zone of faults near Soda Lake was mapped by Farrington (1974) (figure 2b). Faults mapped by Farrington along the ridge north of Soda Lake are defined principally by closed depressions and troughs. Air photo interpretation by this writer indicates that these geomorphic features are probably caused by landsliding (figure 4b). Short, conjugate faults shown by Farrington may actually be continuous, accurate scarps associated with landsliding on the north side of the ridge (figures 2b, 4b). Sarna-Wojcicki and others (1975) do not show faulting in this area. Armstrong (1980) shows landsliding on the northeast-facing slope of this ridge (figure 2b). Geomorphic features such as back-facing scarps, back-tilted surfaces, and hummocky terrain, are consistent with a landslide interpretation (figure 4b).

Two sub-parallel faults mapped by Farrington (1974) are depicted on the 1974 SSZ Map of the Chittenden quadrangle in the Soda Lake area. The southernmost of the two faults is shown as concealed by Farrington and no evidence for this fault (except for the notch in the abandoned meander scarp just west of Soda Lake) is cited by Farrington. The fault to the north is defined by a bench and south-facing scarp along the north shore of Soda Lake (figure 2b). However, evidence of recent faulting (post-erosional formation of meander scarps) is not indicated, because there is no evidence of offset of the ridge west of Soda Lake except for a vague bench (figure 2b). The south-facing scarp on the north shore of Soda Lake is not well-defined on 1959 air photos and may be the result of erosion along the shoreline. A broad trough in Pliocene Purisima Formation is the principal geomorphic expression, but the fault does not extend into Holocene(?) alluvium (Farrington, 1974; figure 2b, this report). There is geomorphic evidence permissive of Holocene faulting along Farrington's northernmost fault, principally a 2-foot high scarp on an alluvial fan that is on trend with associated fault features indicating Holocene faulting near Chittenden Pass (north-facing scarp, closed depression, and sidehill bench)(figure 2b, 4b).

(6)

Zayante Fault

The Zayante fault depicted on the 1976 SSZ Map of the Watsonville East quadrangle is based on mapping by Hall and others (1974) (figure 2a). The decision to zone the Zayante fault was based on a possible offset of Holocene deposits (vertical sense, northeast side down) in the College Lake area near the west border of the Watsonville East quadrangle (figure 2a).

Displacement on the Zayante fault is predominantly vertical, indicated by cumulative vertical offset of 3,000 feet to 10,000 feet of post-Mesozoic rocks (southwest side up) across the fault (Clark and Rietman, 1973). No significant lateral offset has been observed along the Zayante fault, although an unspecified amount of horizontal offset may have occurred, based on the distribution and types of granitic rocks across the fault (Ross and Brabb, 1973). Clark and Rietman (1973) indicate that the Zayante fault is covered by Quaternary sediments in the FER study area. Dibblee and Brabb (1978) do not show Holocene or even late Pleistocene deposits offset by the Zayante fault in the Watsonville East quadrangle.

A subtle northeast-facing scarp about 3,000 feet long associated with vegetation contrasts delineates a possible segment of the Zayante fault in the Watsonville East quadrangle, based on air photo interpretation by this writer (figure 4a). The scarp offsets Holocene "basin deposits" (Dibblee and Brabb, 1978) in the College Lake area and extends for about 2,000 feet northeast into the Watsonville West quadrangle coincident with a linear ridge. Discontinuous tonal lineaments and modified scarps in Pleistocene terrace deposits can be followed in the Watsonville West quadrangle between Pinto Lake and Corralitos, but none of these features are well-defined.

6. Conclusions

San Andreas Fault

The San Andreas fault is generally well-defined in the Watsonville East quadrangle, although landsliding obscures geomorphic evidence along segments of the fault. Historic surface fault rupture occurred along this stretch of the fault during the 1906 earthquake, but specific fault traces were not documented (Lawson, 1908). Evidence of fault creep along the San Andreas fault extends as far north as the Watsonville East quadrangle, where fault creep of about 0.8 mm/year was measured during the period 1967 to 1972 (Burford and Harsh, 1980). Branch faults mapped by Hall and others (1974) are not well-defined, and evidence of Holocene offset was not observed (figure 2a). A later map by Sarna-Wojcicki and others (1975) depicts most of these branch faults as concealed (figure 2a). Fault traces mapped by Hall and others (1974), Hart (1979), Smith (1979), and this writer (figure 4a, this report) adequately delineate principal traces of the San Andreas fault in the Watsonville East quadrangle.

The San Andreas fault in the Chittenden quadrangle is less well-defined than in the Watsonville East quadrangle (figures 2b, 4b). The main trace San Andreas fault is located along the Pajaro River for about 1 1/2 km and trends southeast generally through a linear valley parallel to Anzar Road (figures 2b, 4b). Right-lateral offset of 3 1/2 feet occurred at the railroad bridge spanning the Pajaro River during the 1906 earthquake (Lawson, 1908) (figure 2b). A fence was offset 4 feet right-laterally in 1906 in the vicinity of Anzar Road (figure 4b), but the locality description is too vague to identify a specific fault trace (Lawson, 1908). A short fault trace thought by Farrington (1974) to have ruptured in 1906 is delineated by a sag pond, but no additional geomorphic features associated with faulting can be observed (figure 2b). Farrington based the fault location on a photo in the Lawson report (figure 6) of a sag pond associated with surface rupture during the 1906 earthquake. The sag pond in figure 6 does not seem to be the sag pond referred to in the Lawson report.

Faults mapped by Farrington (1974) in the Soda Lake area generally are not well-defined and do not offset Holocene deposits (figure 2b). Faulting on the ridge north of Soda Lake may actually be landsliding (figures 2b, 4b), and Armstrong (1980) and Dibblee and Brabb (1978) do not map faults in this location.

Zayante Fault

The Zayante fault of Hall and others (1974) is mapped as discontinuous, inferred or querried faults in the Watsonville East quadrangle. Possible Holocene faulting is indicated by a subtle northeast-facing scarp in Holocene deposits (Hall and others, 1974). This subtle northeast-facing scarp is associated with vegetation contrasts and can be observed for about 3,000 feet in the Watsonville East quadrangle. The northeast-facing scarp is associated with a linear ridge for about 2,000 feet in the adjacent Watsonville West quadrangle. Geomorphic evidence of faulting cannot be found southeast of the subtle scarp in basin deposits. Dibblee and Brabb (1978) and Clark and Rietman (1973) do not map the Zayante fault in late Quaternary deposits in the Watsonville East quadrangle.

7. Recommendations

Recommendations for zoning faults for special studies are based on the criteria of sufficiently active and well-defined (Hart, 1980).

San Andreas Fault

a. Watsonville East quadrangle: Zone for special studies well-defined traces of the San Andreas fault shown on figure 5a, based on Hart (1979), Smith (1978), Hall and others (1974), and Bryant (this report, figure 4a). Do not zone branch faults of Hall and others (1974) because these traces do not meet the criteria of sufficiently active and well-defined.

b. Chittenden quadrangle: Zone for special studies well-defined traces of the San Andreas fault shown on figure 5b, based on Farrington (1974), ~~Bishop (1969)~~, and Bryant (this report, figure 4b). Do not zone faults (7) in the Soda Lake area, based on Farrington (1974), except as shown on figure 5b.

Zayante Fault

Zone for special studies the trace of the Zayante fault shown on figure 5a, based on Bryant (this report, figure 4a). Additional short fault traces of Hall and others (1974) depicted on the 1976 SSZ Map of the Watsonville East quadrangle are not well-defined and should not be zoned.

8. Report prepared by William A. Bryant, 2/24/81.

William A. Bryant

OK - rezone
as indicated.
EWH
3/31/81

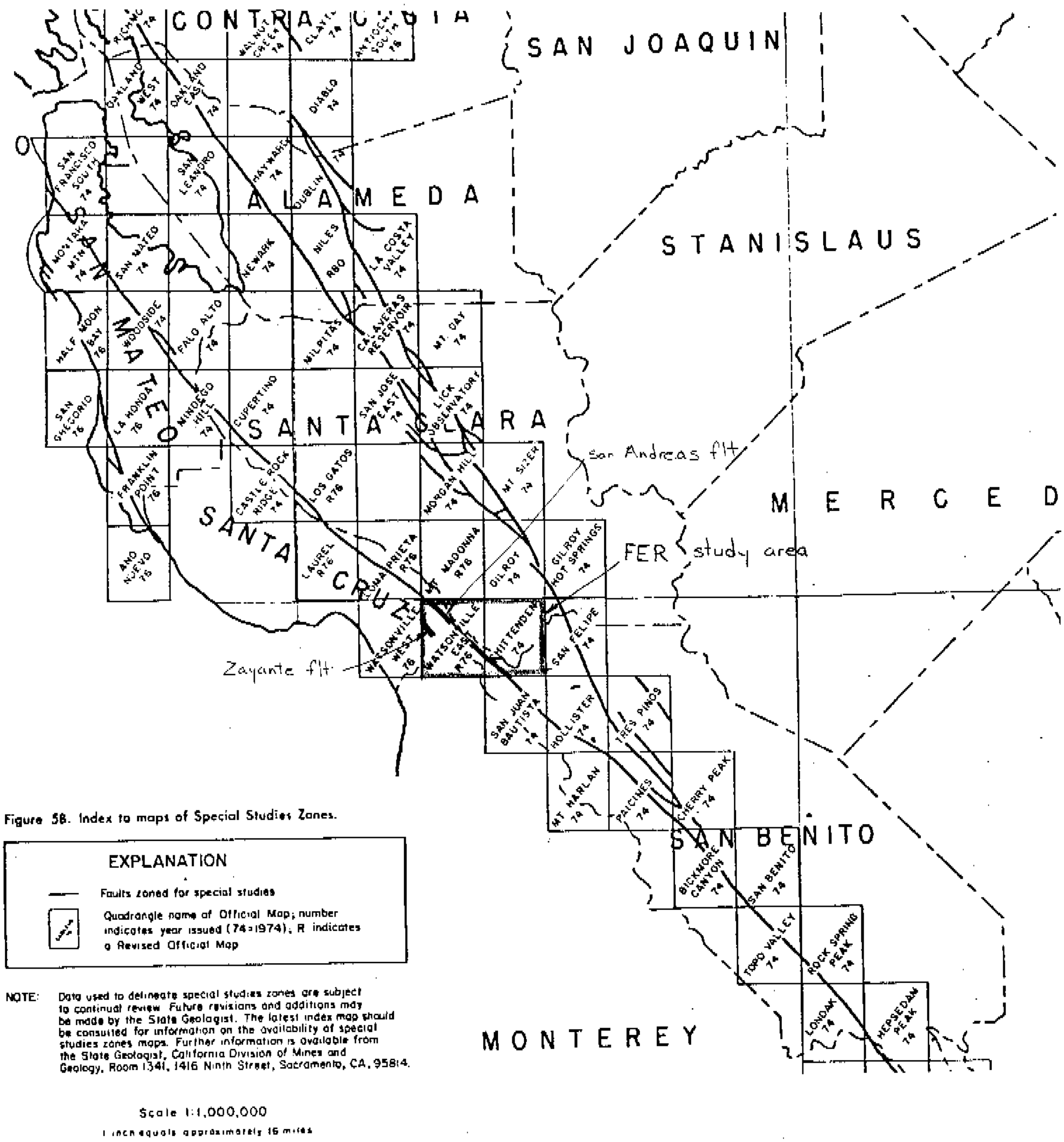

Figure 1 (to FER-113). Index to main faults and Special Studies Zones, Watsonville East and Chittenden quadrangles (from CDMG Special Publication 42, p. 13).

17 B. The Rift a mile southeast of Chittenden. Pond on upper slope of hill. H. W. F.

Figure 6 (to FER-113). View northwest (?) toward Pajaro Gap, showing sag pond associated with surface fault rupture during the 1906, M 8 earthquake (Lawson, 1908, Plate 17B, p. 38). Farrington (1974) assumed this sag pond to be the one located near School Road in the Chittenden quadrangle (figure 2b).